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TECHNICAL NOTE

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Efficiency measurements of the Trigger4 beam monitor in H6

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Abstract

The calibration factor of the CERF beam monitor (PIC), i.e. the relation between PIC-counts and the number of beam particles, is regularly verified by means of the Trigger4 scintillation detector. This is done by comparing the number of counts of the beam monitor with those of the scintillator. For that purpose the efficiency curve of the Trigger4 should be recorded every time before using this detector in order to obtain absolute values of the beam intensity. This note describes the efficiency measurements of Trigger4 and the verification of the PIC calibration factor during the CERF run in June 2002.

1 Motivation

The CERF beam monitor, a precision ionization chamber (PIC), was first calibrated in the years 1993/94 in a series of activation measurements, using plastic scintillators, graphite plates and polyethylene foils [Car93, Hoo93, Liu93, Roe94, Ste94a, Ste94b]. This resulted to a calibration factor of $2.2\times10^4 \pm 10\%$ primary particles per PIC-count. In 1998 a verification of the PIC calibration was done by comparing the responses of the the PIC with three scintillators installed in the H6 beam-line [Els98a]. The results of these measurements showed that the calibration factor was in agreement with the 1993/94 measurements. In 1999 the PIC was calibrated again with beam scintillators [Gsc00c, Mit01a], however in a more precise way, *i.e.* including background subtraction, dead time correction and detailed error analysis. These measurements gave a calibration factor of $2.3\times10^4 \pm 5\%$ primary particles per PIC-count, which is consistent with the former one. In the following years no new calibration of the PIC was performed but at the beginning of each run the calibration factor of the PIC was quickly verified by means of the Trigger4 scintillator. This report describes such a verification of the calibration factor of the PIC during the June 2002 CERF run.

2 The Trigger4 beam monitor

The Trigger4 beam monitor is installed 40 m upstream of the PIC and routinely used for aligning the beam. It is rather close to the PIC and therefore it is chosen for the calibration and verification measurements. It is a scintillator with a diameter of 100 mm, a thickness of 2 mm, partly surrounded by a light guide and attached to a photomultiplier (PMT). The operating voltage of the detector should be set in the plateau region of its efficiency curve, to give a signal for each particle in the beam. The Trigger4 saturates already at about 6.3×10^6 particles per second which corresponds to about 300 PIC-counts per second as former experiments have shown [Gsc00c, Mit01a]. For higher intensities dead time correction must be applied in order to obtain correct results [Gsc00c, Mit01a].

3 Measurements

In order to verify the PIC calibration factor, *i.e.* the relation between PIC-counts and the number of beam particles, the number of counts of the PIC were compared with those of the beam scintillator.

The PIC-counts were read out online with a LabView Programme running on a PC. The number of beam scintillator counts were received directly from the

SPS beam-control programme. The counting time lasted the entire spill length of t=4.8 s with a repetition cycle of 16.8 s. The beam intensity was set to 380 PIC-counts per spill, corresponding to 80 PIC-counts per second, in order to avoid dead time effects in Trigger4. Background effects were not taken into account.

4 Results and Conclusions

First measurements have shown a great deviation from the former calibration factor, *i.e.* 2.9×10^4 particles per PIC-count. Checking the voltage of the PIC battery has shown that it had significantly decreased to 140 V (the nominal value being 300 V). Nevertheless this voltage is sufficient to avoid recombination in the ionization chamber for intensities well above 4000 PIC-counts per second [Mit01b, Mit01a]. In the following the efficiency curve of Trigger4 was recorded in order to investigate if the operating voltage of -2.1 kV lies within the plateau region. For that purpose the HV of the PMT was varied in the range between -1.7 kV and -2.2 kV and the number of counts obtained with the Trigger4 normalised to the incident protons on the T4 target was measured.

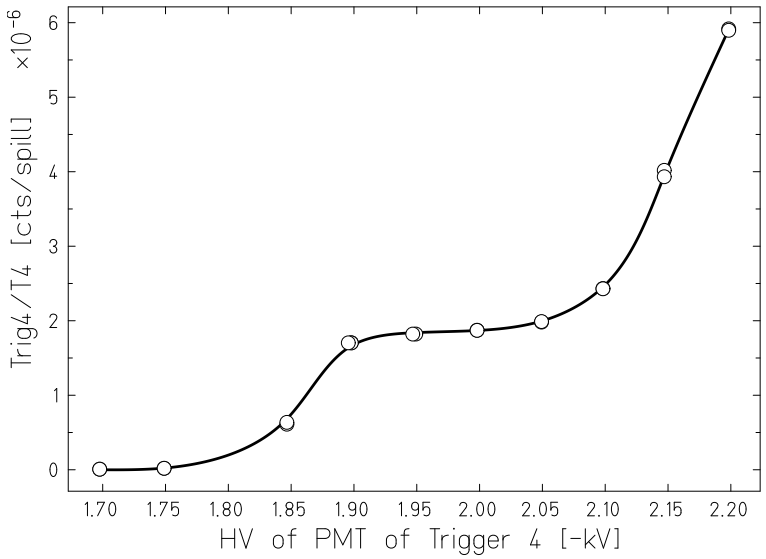

Figure 1: *Efficiency curve of the Trigger4 beam scintillator. Counts of the beam scintillator Trigger4 normalized to the primary protons on the production target T4 as a function of high-voltage (HV) of the photomultiplier (PMT).*

As seen from Figure 1 the actual operating voltage of the PMT of -2.1 kV is not within the plateau region of the efficiency curve but on the slope behind. This explains why a higher ratio between PIC and Trigger4 was measured. Resetting

the HV to -1.95 kV and comparing the PIC with Trigger4 then gave now $2.2\times10^4\pm$ 10%, and thus verifying the calibration factor of the PIC.

Finally it should be remarked that the plateau region of the Trigger4 detector is shifting with time. While in 1999 it was between -2.05 kV and -2.10 kV [Gsc00c, Mit01a] it ranged between -1.90 kV and -2.05 kV during the June 2002 CERF run. The efficiency curve of Trigger4 should be recorded every time before using this detector for absolute measurements of the beam intensity.

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